DOCUMENT RESUME

ED 281 495 IR 012 611

AUTHOR Gundlach, Ann C.
TITLE An Annotated Bibliography of the Literature Dealing with the Evaluation of Educational Microcomputer Software.
PUB DATE Apr 85
NOTE 75p.; Exit Project, Indiana University at South Bend.
PUB TYPE Reference Materials - Bibliographies (131) -- Dissertations/Theses - Undetermined (040)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Annotated Bibliographies; *Computer Assisted Instruction; *Courseware; Elementary Secondary Education; *Evaluation Criteria; *Instructional Material Evaluation; Microcomputers

ABSTRACT

Designed to assist the educator in making informed decisions about the quality and selection of instructional microcomputer software, this annotated bibliography examines literature dealing with the need for software evaluation, evaluation criteria, and the effectiveness of computer-assisted instruction. Introductory materials provide a brief overview of the problems involved in software evaluation, the organization and limitations of this study, and a glossary of computer terms used in the report. A summary of the findings of the literature review and recommendations for future research, for evaluation forms and criteria, and for school policies conclude the report. A detailed analysis of the criteria used on selected evaluation forms is appended. (MES)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED281495

AN ANNOTATED BIBLIOGRAPHY OF THE LITERATURE DEALING WITH THE EVALUATION OF EDUCATIONAL MICROCOMPUTER SOFTWARE

BY

ANN C. GUNDLACH

Graduate Student

Study Directed

by

Charles R. DuVall, Ph.D.

IR012611

Submitted in partial fulfillment of the requirements
for the course E591--Exit Project
Indiana University at South Bend
April, 1985

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Ann C. Gundlach

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

BEST COPY AVAILABLE

TABLE OF CONTENTS

	Page
INTRODUCTION	1
The Statement of the Problem	2
Purpose of the Study	2
Organization of the Study	3
Limitation of the Study	3
Glossary	4
ANNOTATIONS	10
Is There a Need for Evaluating Microcomputer Software?	10
Is Computer-assisted Instruction Effective?	14
What Criteria Should Be Used?	21
SUMMARY	35
Survey of Selected Microcomputer Software Evaluation Forms	41
CONCLUSION	45
RECOMMENDATIONS	48
BIBLIOGRAPHY	49
APPENDIX A	54
APPENDIX B	56
APPENDIX C	58
APPENDIX D	62
BACKGROUND	63

INTRODUCTION

Computers have made their way into classrooms across the United States. According to a survey conducted at Johns Hopkins University, a majority of schools now have at least one microcomputer used for instruction of students. (Becker, 1983, p. 2) Another survey at Indiana University found that U.S. schools increased their microcomputer total by 154 percent in 1983. The data indicated that there were 330,000 microcomputers being used in 50,000 schools throughout the country. (Smith and Ingersoll, 1985, p. 11)

Elliott, Ingersoll, and Smith revealed that at all grade levels, teachers' attitudes toward microcomputers were generally positive. Over 74 percent were happy to see new technology entering the classroom. They perceived the computer as having great potential for teaching and for management in their classrooms. (p. 15)

Even though teachers had very positive attitudes toward the microcomputers, they felt that the software now available was of low quality. They regarded it as unimaginative and boring. (Elliott, Ingersoll, and Smith, 1983, p. 20) Schools were found to be spending one-fiftieth as much for software as they were for hardware. (Smith and Ingersoll, 1985, p. 26) If quality educational microcomputer software does not join the computer in the classroom, then the enthusiasm which now exists surely will fade. If computers are to reach the potential envisioned for

them, it seems axiomatic that schools will have to find a process that will allow them to choose quality software that serves their needs. The careful evaluation of educational software coupled with judicious purchasing, will send a direct message to the producers and will encourage them to upgrade the quality of their products.

THE STATEMENT OF THE PROBLEM

Evaluating a microcomputer software program should be the first step toward making the decision to add a program to a school's collection; however, educators often must select software using no well-researched criteria on which to base decisions for purchasing these materials.

PURPOSE OF THE STUDY

This study deals with the literature concerning the evaluation of educational microcomputer software. In addition, it will present an analysis of selected evaluation forms.

In order to acquire high quality software to use in the classroom, the educator should know what criteria he should use with which to evaluate programs he is considering for purchase. By examining the literature dealing with evaluation, it may be possible to lead the evaluator toward making more informed decisions about the selection of instructional microcomputer software.

ORGANIZATION OF THE STUDY

Is there a need for evaluating microcomputer software? The initial portion of the study will attempt to answer this question.

Is computer-assisted instruction effective? This is a question that should be addressed, for effectiveness of a method is of great importance to both the teacher and the learner. An investigation of the literature concerning effectiveness will attempt to illumine this area.

What criteria should be used? Further readings will focus on the question of evaluation criteria.

Finally, a survey of the criteria of selected evaluation forms will be presented and discussed.

LIMITATION OF THE STUDY

It was perceived at the beginning of this study, that there was much research literature concerning the evaluation of microcomputer software. As the readings progressed, it was found that very little hard research was available other than in the area of effectiveness in achievement in subject-matter. There was, however, a profusion of opinion pertaining to evaluating software. Time constraints limited the investigation of all related literature, but it is believed that the annotations included are a representive sampling, and further study would not greatly alter the conclusions drawn.

GLOSSARY

branching program -- "an instructional program designed in such a way that the student's progress through the program is determined by the specific answers given. If remedial work is required, the microcomputer will take the student into a remedial branch and provide the work necessary before continuing through the main portion of the program. The path a student uses is determined by that student's response." (Douglas and Neights n.d.:22)

bug -- "an error--usually in a procedure or in a computer program. However, it can also refer to a hardware error." (Billings and Moursund 1979:142)

CAI -- See Computer-Assisted Instruction.

CBI -- See Computer-Based Instruction.

CMI -- See Computer-Managed Instruction.

compatibility -- "there are two types of compatibility: program and hardware. The program compatibility refers to the ability to run programs on a variety of computers without changing the program language. Hardware compatibility means the various components (printers, disks, keyboards, etc.) may be connected directly without intervening electronic devices. Compatibility also should be considered between the computer program and the normal instructional program used in the school." (Douglas and Neights n.d.:23)

computer -- "a device that can input, store, manipulate, and output data. It can automatically follow a program (a detailed step-by-step set of directions)." (Billings and Moursund 1979:142)

computer-assisted instruction -- "direct instruction conducted by the computer. Examples of this type of instruction are: drill and practice, tutorial, simulation and gaming, information retrieval, and problem solving." (Douglas and Neights n.d.:23)

computer-based instruction -- "the overall term used to describe the use of computers in the instructional process. Usually divided into two areas: computer-assisted instruction and computer-managed instruction." (Douglas and Neights n.d.: 23)

computer graphics -- "the use of computers to deal with picture-type information. A computer terminal with a graphics display screen is a common input/output device for computer graphics." (Billings and Moursund 1979:142)

computer-managed instruction -- "instructional support functions conducted by the computer. Examples of the support functions are: testing, prescribing, record keeping, schedule monitoring, and time and resource management." (Douglas and Neights n.d.:23)

content -- "facts, terms, ideas, concepts, principles, theories and constructs which make up the subject matter of an instructional package." (Otte 1984:9)

courseware -- "software and printed materials which support instruction in a complete course of study or a definable subset of a course." (Otte 1984:9)

crash -- "unplanned hardware or software termination." (Freedman 1983:70)

data -- "facts, recorded measurements, and other information. In the computer field, the word data usually refers to information to be processed by a computer." (Billings and Moursund 1979:143)

drill and practice. -- "an instructional program that assumes that the concept or skill has been taught; merely reinforces." (Heck et al. 1984:14)

feedback -- "information received by the student immediately after each of his responses to the programmed material." (Good 1973:237)

formative evaluation -- "evaluation conducted in the process of materials development. Directed at assessing and improving ingredients and procedures of the materials." (Dennis 1979:3)

graphics -- See computer graphics.

hardware -- "mechanical, magnetic, electrical and electronic devices which make up a computer. The physical equipment that goes into a computer system consisting of the central processing unit plus all the peripherals." (Douglas and Neights n.d.:24)

input -- "data/information entered into the computer." (Freedman 1983:144)

linear program -- "a program written in such a way that all students must proceed through each step or question of the program." (Douglas and Neights n.d.:25)

mainframe -- "a computer system's hardware consists of a mainframe and peripherals. The mainframe includes the central processing unit and primary storage." (Billings and Moursund 1979:145)

MECC -- Minnesota Educational Computing Consortium.

menu -- "a list of available options in an interactive program. Menus display all options available to the user at the terminal." (Freedman 1983:177)

meta-analysis -- "term first used by Glass (University of Colorado 1976) to describe the statistical analysis of a large collection of results from individual studies for the purpose of integrating findings." (Kulik 1980:527)

microcomputer -- "a small scale computer; microcomputers were the first computers to use a single microprocessor chip as the processor. Personal computers and small business computers are microcomputers." (Freedman 1983:179)

mode -- "the form or manner, as in 'mode of communication' or 'teaching mode'." (Good 1973:370)

package -- "one or more computer programs with related materials and the storage medium." (Otte 1984:9)

output -- "computer generated information; output refers to any computer generated information in the form of hard copy, soft copy or machine readable form (such as disk or tape)." (Freedman 1983:183)

peripheral device -- "a device, such as a printer, mass storage unit, or keyboard, which is an accessory to a microprocessor and which transfers information to and from the microprocessor." (Douglas and Neights n.d.:25)

problem solving -- "a technique most commonly applied to the physical sciences and mathematics. This technique is also appropriate for teaching consumerism, resource conservation, interpersonal relationships and other subjects where problems can be defined." (Douglas and Neights n.d.:13)

program -- "a detailed step-by-step set of directions telling a computer how to perform a procedure." (Billings and Moursund 1979:146)

simulation -- "programs that attempt to represent key aspects of some environment within which the user will need to make decisions and will be informed of the results of those decisions without experiencing the real consequences of possible misjudgments." (Heck et al.1984:12)

software -- "the programs and accompanying documentation." (Douglas and Neights n.d.:26)

summative evaluation -- "evaluation conducted after development is completed, to determine learning outcomes derived from materials." (Dennis 1979:3)

tutorial -- "tutorial computer teaching is closely related to the traditional lecture method. Information is presented in an organized fashion, including frequent one-to-one reinforcement, as the learner responds. A summary of key concepts and information learned may be found at the end of each unit." (Douglas and Neights n.d.:13)

user -- "anyone using the computer; user usually refers to the non-technical person providing input to, or receiving output from the computer." (Freedman 1983:275)

ANNOTATIONS

IS THERE A NEED FOR EVALUATING MICROCOMPUTER SOFTWARE?

Elliott, Peggy, Gary M. Ingersoll, and Carl B. Smith. Trends in Educational Materials Traditionals and the New Technologies. Bloomington, IN: Educational Research Association of Indiana, (1983): 1-20.

When reporting about microcomputers, Elliott, Ingersoll, and Smith said that "evidence drawn from (studies) indicate the potential for a major 'revolution' in education." (p. 1) They attributed this trend to lowered cost and greater capacity of hardware, simplification of use, and increased popularity of computers in the home. The attitudes of teachers toward computers were generally positive. Although over 74 percent were happy to see new technologies enter the classroom, the attitudes toward software were quite different. Software was seen as inferior and as providing for little creativity or higher-level thinking skills. The report issued a warning when it said that teachers viewed "current software (as) dull, unimaginative and of questionable soundness. Many programs are little more than electronic flashboards. Until developers capitalize on effective pedagogical and motivational techniques, this problem will persist. If any one factor hinders the growth of the educational computer market, it will be that software developers fail to take advantage of such techniques." (p. 20)

Cory, Sheila. "A Four-Stage Model of Development for Full Implementation of Computers for Instruction in a School System." The Computing Teacher, 11.5 (November 1983): 11-16.

Cory described a conceptual model of stages that schools seemed to go through before they could fully utilize computers. She identified four stages. At each stage six factors were identified and their characteristics cited: hardware, software, staff development, computer-assisted learning, computer literacy, and attitude. Relative to development of software through the stages, she pictured stage one as having very little software acquired, and what was available, was either public domain or teacher written. At stage two the acquired software was inexpensive or free, frequently had bugs, and was often purchased by an individual teacher. At this stage the school might have purchased MECC software. In stage three there was a greater acquisition of professionally developed software and a wide variety of software was purchased. In the final stage, the purchase of software was based on thorough evaluation and plans to tie the software to the curriculum.

Rose, Shelley Yorke, and Carol Klenow. "The DISC Model for Software Evaluation and Support Material Design." The Computing Teacher, 11.1 (August 1983): 32-33.

The DISC (Documentation and Integration of Software into the Classroom) Project was implemented in Oakland County, MI. Its purpose was to create a network of educators trained in the evaluation of software. These teachers attended four sessions to be trained to evaluate software and to create accompanying support materials for each program selected for purchase. The requirements for effective classroom use addressed available classroom time, an overview of the program, and teacher lesson plans to direct users as to how the program would fit into a unit of instruction. Three worksheets were designed to accompany each program. Their purpose was: to relate the computer activity to classroom objectives, to follow up computer use with activities such as discussions or projects, and to enable the teacher to record how the students interacted with the computer. The reviews and materials were assembled in the DISC Compendium and were made available to the users of the more than 2000 microcomputers in the 28 districts of Oakland County. The plan saved money and duplication of effort.

Allard, Kim, and Bob Reid. "Courseware Evaluation: The SECTOR Project." Educational Computer Magazine, 3.2 (March/April 1983): 22-26.

Allard and Reid described the SECTOR (Special Education Computer Technology Online Resource) project at Utah State University. "All courseware is evaluated against an 'ideal' criterion that contains what (they felt were) the major attributes and features of state-of-the-art software." (p. 22) Software was procured on a review only basis. A team of three reviewers, led by a chief reviewer, independently reviewed the courseware. Reviews addressed content, instructional design, record keeping/management and ease of use. The review was completed when reports from each team member were assembled, discussed, and a consensus was reached. A checklist was not used even though it would have been faster. Narrative reports gave more information. The team felt that reviews should be informative, for even programs with excellent ratings in all areas could be unsuitable for many users. They stated that "good courseware is that which suits (the) instructional environment and needs, and makes effective use of computer capabilities." (p. 24)

Caldwell, Robert M. "Evaluating Microcomputer Software in the English Language Arts." English Education, 16.1 (February 1984): 14-21.

Caldwell stated that English teachers have found that microcomputer programs could not only drill on basic skills but were useful for teaching writing skills and organizing ideas and information. Instead of analytical descriptions, Caldwell called for careful descriptions of what the software did and how it might be used to improve language arts instruction. He asserted that evaluation guidelines contained serious problems relating to the validity of the criteria and the procedures used for evaluation. "Few of the criteria used to evaluate available software have been validated in any sort of well-conducted research. Few criteria can be identified that . . . demonstrate . . . a clear relationship between a specific feature of a software program and its effect on learner achievement." (p. 17) Caldwell stressed that all criteria should not be weighted equally, and criteria could not be designed to be applied to all software programs regardless of teaching strategy.

Kohl, Herbert. "Who Should Be Evaluating Software?" Classroom Computer Learning, 5.2 (September 1984): 30-33.

Kohl stated that many educators were looking for exact criteria to evaluate software. They were afraid that without accepted evaluation criteria, personal judgement would play too large a role in choosing software for purchase. Kohl said that he had reviewed a number of evaluation protocols and found that they contained many "invalid assumptions about learning and computers." (p. 32) Kohl listed his personal criteria for choosing a software package. "Is the computer necessary to teach the program, or could it be done equally well without the computer? . . . Is it fun? . . . Can it be varied and experimented with, so that the practice helps internalize the learning? . . . Would (one) buy it (himself)? . . . Is it open-ended so that it can be modified? . . . Are moral values built into the program so that such things as killing are not treated casually?" (p. 33) Kohl insisted that we "cannot determine the best software objectively through lists of behavioral goals or by keying software to a curriculum that itself may be questionable." (p. 33) What was needed was good judgement and sensitivity.

Fetter, Wayne R. "Guidelines for Evaluation of Computer Software. Educational Technology, 24.3 (March 1984): 19-21.

Fetter stressed that guidelines for evaluation of software must be developed and followed by those responsible for materials selection. Users have the responsibility to evaluate programs critically and then to inform producers of their findings. Fetter divided his guidelines into five major categories: (1) product information; (2) appropriateness; (3) content; (4) organizational and technical components; (5) technical or teacher's manual evaluation and product revision. He included a sample evaluation form.

Manning, Anita. "Good Learning Software Is Hard to Find." USA Today, 6 March 1985b, sec. D, p. 1D.

Manning stated that complaints from both teachers and students were growing due to the lack of quality instructional software available. "Too often," she said, "glowing catalog descriptions belie programs that are disappointing in the classroom. And few publishers allow in-school trials before purchase." (p. 1D) Manning quoted her sources as saying that most programs "offer little guidance on use, . . . are unimaginative, unclear, inadequate . . . (and) use 10 percent of the computer's capacity." (p. 1D) She quoted P. Kenneth Komoski, the executive director of the Educational Products Information Exchange, Columbia University, NY, as saying that their research showed that "only 1 out of 10 pieces of educational software has been shaped through trial by the learner as the program is being developed." (p. 1D) Other educators saw some improvement in quality, although it was slight.

Manning, Anita. "Educational Software Is Put to the Test." USA Today, 6 March 1985a, sec. D, p. 3D.

Manning reported some statistics from the Educational Products Information Exchange, Columbia University, NY. These figures showed an oversupply of software programs in some areas and a shortage in others. If "you need a basic math program . . . there are 1,219 to choose from, but (if) you want one on statistics, . . . you will find no more than 19. There are 244 programs on physics, but just 18 on general science." (p. 3D) Market demand seemed to regulate what kinds of programs were written. Manning also reported that "only 10 percent of the programs listed in (the EPIE's) guide have been evaluated in depth . . . and only 20 to 25 percent of the programs have been evaluated by anyone." (p. 3D)

IS COMPUTER-ASSISTED INSTRUCTION EFFECTIVE?

Fisher, Glenn. "Where CAI Is Effective A Summary of the Research." Electronic Learning, 3.3 (November/December 1983): 82-84.

Fisher summarized the research surveys of Burns and Bozeman (1981), Dence (1980), and Forman (1982). He found that most research over the past 20 years led researchers to conclude that computer-assisted instruction was effective if certain conditions were met: "when it was aimed at . . . specific groups; when it was fully integrated into the classroom curriculum; when certain subject areas were selected; and when the proper setting and scheduling was established." (p. 82) It was found to be most effective in the subject areas of science and foreign languages for both high achievers and low achievers when it supplemented the curriculum. It was moderately effective in mathematics and with middle achievers, and it was less effective in reading and language and when there was no teacher input. The one variable that was most difficult to measure was the quality of the software used, and most studies had not focused on this. All studies Fisher examined reported a significant positive change in attendance, attention span, and motivation of students. Another finding was that students began to feel that they had more control over events.

Atkinson, Richard C. and Patrick Suppes. An Automated Primary-Grade Reading and Arithmetic Curriculum for Culturally Deprived Children. Stanford, CA: ERIC Document Reproduction Service, (1968), ED 023 773. (Microfiche)

Atkinson and Suppes reported on a project whose main objective was to develop "an instruction program in mathematics and initial reading . . . to individualize instruction so that each child could progress through a subset of materials best suited to his particular aptitudes and abilities at his own pace." (p. 141) One hundred children were the subjects. Two classes served as controls and two as experimental groups. One group of two classes was of average ability, the other two classes being compared were of below-average ability. After one school year, the classes were compared using the Stanford Achievement Test. In the average ability groups, the mean performance of the experimental group showed no significant difference from the control group. However, "in comparing the two classes of below-average ability, the difference between the experimental class and the control class was highly significant statistically and in favor of the experimental group." (p. 141)

Suppes, Patrick, and Mona Morningstar. "Computer-Assisted Instruction." Science, 166 (October 1969): 343-350.

Suppes and Morningstar reported the findings of a drill and practice program in elementary mathematics conducted in both California and Mississippi. They also reported results from a second study, a tutorial program of elementary Russian at Stanford University. All of these studies were conducted in the classical manner using experimental and control groups and comparing their relative rates of achievement. In the elementary schools, 5 to 8 minutes of computer-assisted instruction was given each day to the experimental groups. It was found that the performance of the experimental groups, which was tested using the Stanford Achievement Test, was significantly better in most cases than that of the control groups. The results in both California and Mississippi showed significant gains for both the applications and the concepts sections of the SAT. The study of computer-assisted instruction in Russian was conducted on students at Stanford University. The results showed that 74 percent of the students in the experimental groups performed better on final examinations than the best student in the conventional groups. Suppes and Morningstar concluded from their results that computer-assisted instruction was effective in both mathematics and language instruction.

Vinsonhaler, John F., and Ronald K. Bass. "A Summary of Ten Major Studies on CAI Drill and Practice." Educational Technology, 12.7 (July 1972): 29-32.

Vinsonhaler and Bass summarized the results of ten independent studies involving the use of CAI in the areas of both mathematics and language arts at the elementary school level. Over 10,000 subjects were included in the experiments. All the studies used the drill and practice mode to strengthen and maintain skills. Performance was determined by an average gain score. Standardized achievement tests were used, and scores were derived from the difference between pretest and posttest scores. All studies used the experimental/control group design. The experimental group was given traditional classroom instruction plus CAI drill and practice, and the control group received only classroom instruction. In language arts all differences were positive. They ranged from one tenth to four tenths of a school year in favor of CAI groups. In mathematics, five of seven experiments showed differences favoring CAI programs. Vinsonhaler and Bass concluded that at the elementary level there seemed little doubt that CAI plus traditional classroom instruction was usually more effective than traditional classroom instruction alone.

Dence, Marie. "Toward Defining the Role of CAI: A Review." Educational Technology, 20.11 (November 1980): 50-54.

Dence's study examined the variables addressed in seventeen studies on CAI. The studies were conducted during the late 1960's and in the 1970's. She found that "the major focus was on subject matter and global comparisons of CAI to traditional instruction." (p. 51) There were no other clear trends. This indicated that the research was not going in any one direction. Those studies which had subject matter as a variable, found that foreign languages and the sciences were two areas where CAI was effective. Drill and practice was found to give students a greater advantage over traditional instruction, and branching was found to be more effective than non-branching. Feedback was found to be more effective when it was delayed rather than immediate. When CAI was compared with traditional instruction, it was found to be at least as effective in a majority of studies, (55 percent) and more effective in 45 percent. Dence called for more research to find student characteristics that respond well to CAI. Researchers should examine areas such as "split-brain research, cognitive style, anxiety level, and personality types" (p. 54) to find where CAI could be used effectively to individualize learning.

Burns, Patricia Knight, and William C. Bozeman. "Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship?" Educational Technology, 21.10 (October 1981): 32-39.

Burns and Bozeman conducted a meta-analysis of 40 studies in order analyze and integrate the findings of research relative to the effectiveness of computer-assisted mathematics instruction in elementary and secondary schools. They examined studies in which CAI was utilized as a supplement to, rather than a replacement for, traditional classroom instruction, and in which drill and practice or tutorial modes of computer-assisted instruction were used. They looked only at studies where the performances of an experimental group were compared with a control group and in which the outcome was measured by student achievement. They found that a mathematics program, supplemented by drill and practice or tutorial CAI instruction, was significantly more effective in fostering student achievement than the programs using only traditional classroom instructional methods. They also found that those who benefited most were the high-achieving students and the low-achieving students. Students of average level were not significantly effected. Gains were more evident with boys than with girls.

Yates, Daniel S. "In Defense of CAI: Is Drill-and-Practice a Dirty Word?" Curriculum Review 22.5 (December 1983): 55-57.

Yates noted that in the late seventies much software was rushed into the marketplace and was poorly designed. Drill and practice courseware received a bad reputation. He pointed out that some programs were designed by programmers who knew little about teaching, and some were designed by teachers who knew little programming. He thought a case should be made for CAI. He referred to the studies of Suppes and Morningstar (1969) and Vinsonhaler and Bass (1972) whose findings gave "rather strong evidence for the effectiveness of CAI over traditional instruction where effectiveness was measured by standardized achievement tests." (p. 55) He indicated that the courseware being produced now has improved from that of several years ago, and that CAI should be an important option for educators to use with students who could benefit from it.

Fisher Glenn. "The Social Effects of Computers in Education." Electronic Learning 3.6 (March 1984): 26, 28.

Fisher reported that there has been little research done in the area of attitudes and behavior of students using computers. There was research being conducted now which looked at three areas of the affective domain: "attitude and self-image results, behavioral results, and social changes." (p. 26) Although the teaching of programming has claimed to be beneficial to the development of logical thinking, some studies have shown significant gains in this area while others showed no gains at all. Most studies concerning attitude have found that "students feel more positive about themselves and school after exposure to the computer." (p. 26) Teachers who have kept anecdotal records have reported "an almost complete lack of discipline problems in their classes, along with increased attendance and punctuality." (p. 26) Teachers have also reported that the computer fostered good peer interaction and encouraged students to work together more cooperatively. Fisher said that anecdotal records are not enough, and further research was needed "on the effects of different uses of computers on student attitudes and achievements." (p. 28)

Steele, Kathleen J., Michael T. Battista, and Gerald H. Krockover. "The Effect of Microcomputer-Assisted Instruction on the Computer Literacy of Fifth Grade Students." Journal of Educational Research, 76.5 (May/June 1983): 298-301.

Steele, Battista, and Krockover found that fifth grade students who had CAI in mathematics showed significant gains in computer literacy when compared with those students who had equivalent instruction in mathematics without using a microcomputer. Eighty-six fifth grade students were assigned to two groups. One group received ten minutes of computer-assisted instruction twice a week for one school year, in addition to the daily mathematics lesson. The other group used an individualized paper and pencil kit of drill and practice materials. They also worked ten minutes twice a week for one school year in addition to the daily scheduled lesson. Both groups were pretested and posttested using the Minnesota Computer Literacy and Awareness Assessment. The experimental group showed significant gains in computer literacy both in the affective and cognitive domains. There was no significant difference in mathematical achievement.

Kulik, James A., Robert L. Bangert, and George W. Williams. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 75.1 (1984): 19-26.

Kulik, Bangert, and Williams' study focused on subjects in grades six through twelve. It was a meta-analysis and designed much as an earlier study on college students. (Kulik, Kulik, and Cohen 1980) Fifty-one studies were analyzed and their findings integrated. The analysis found that students' scores on final examinations "were raised from the 50th to the 63rd percentile." (p. 22) Twenty-five studies favored CBI and two favored conventional instruction. Ten studies were analyzed on attitudes toward subject matter. In eight, students' attitudes were more positive in classrooms using CBI." (p. 24) In four studies, students developed positive attitudes about computers and about the courses they were taking. In two studies, using CBI "reduced substantially the amount of time that students needed for learning." (p. 26)

Kulik, James A., Chen-Lin C. Kulik, and Peter A. Cohen. "Effectiveness of Computer-based College Teaching: A Meta-analysis of Findings." Review of Educational Research, 50.4 (Winter 1980): 525-544.

Kulik's study was a meta-analysis of 59 independent studies. The studies examined "four major types of applications of the computer to instruction: tutoring, computer-managed teaching, simulation, and programming the computer to solve problems." (p. 529) "The outcomes (of the studies) were of five major types; student achievement, correlation between aptitude and achievement, course completion, student attitudes, and instructional time." (p. 532) The study found that there was a small gain in achievement of students in classes using CAI. A typical student in a computer-based class scored in the 60th percentile on achievement examinations, while a typical student in a conventional class scored in the 50th percentile. The rise in scores was approximately the same for high and low aptitude and average aptitude students. There was a positive effect on student attitudes. Students said that they liked their course more when it was based on computer instruction. The greatest finding in this study was the saving of instructional time. The computer taught more quickly. It did its job in about two-thirds of the time required for traditional teaching.

Orlansky, Jesse. "Effectiveness of CAI: A Different Finding." Electronic Learning, 3.1 (September 1983): 58-60.

Student achievement in forty-eight cases was compared at U.S. Government military schools where courses were taught by either conventional or by computer-based instruction. End-of-course tests and overall course grades were used to measure achievement. Achievement was found to be about the same for two-thirds of the cases and superior in about one-third of the cases. The instruction method did not result in lower achievement, but it did not significantly raise achievement. The study did find, however, that CAI saved student time. The median time saving was about 30 percent. Orlansky pointed out that in the military or in business, "where people are being trained and paid for their time, this saving in time could be valuable." He also noted that in schools, "where students are kept for a fixed amount of time, CAI would allow those students who learn at a faster rate to increase their learning because of the increased amount of time available to them." (p. 60)

Bracey, Gerald W. "Computers in Education What the Research Shows." Electronic Learning, 2.3 (November/December 1982): 51-54.

Bracey stated that research studies of computer-assisted instruction showed some results that had consistency. He grouped the results into three categories: achievement, affective/motivational, and social. He cited the research done by Kulik at the University of Michigan. Kulik found that students who received computer-assisted instruction scored better on objective tests than students who received traditional instruction only. The study also found that CAI improved retention when students were tested later, and CAI also improved the speed at which students learned a given amount of material. We should be aware, Bracey stated, that Kulik "did not make any attempt to evaluate the quality of the computer-related materials used." (p. 53) Bracey reported on a study now in progress which tended to confirm that children using computers felt more in control of things. There was no hard research on social outcomes as yet, but Bracey said he and his colleagues "have seen more collaborative, cooperative problem-solving among kids who are doing programming . . . together than anywhere else in schools. . . . Research has shown that CAI is effective, but it has not told us why." (p. 54)

Forman, Denyse. "Search of the Literature." The Computing Teacher, 9.5 (January, 1982): 37-51.

Forman compiled this search to aid educators in finding relevant literature before they made decisions about computer education. She noted the literature that dealt with the effect of CAI on achievement and the cost effectiveness of CAI. She stressed other advantages of computer-assisted instruction. She emphasized the need for computer literacy as computers became more and more a part of everyday life. She listed some of the stumbling blocks that were slowing the implementation of computers into school systems. Given these problems, "lack of funding, incompatibility of courseware and some hardware, an inadequate supply of quality courseware, and the lack of trained teachers," she recommended that schools "concentrate their efforts on areas where CAI has proven itself both effective and cost effective." (p. 49) Forman concluded that as time passed computers will "naturally find their place in the educational system." (p. 49)

WHAT CRITERIA SHOULD BE USED?

Gold, Patricia Cohen. "Educational Software -- New Guidelines for Development." AEDS Journal, 18.1 (Fall 1984): 41-50.

Gold suggested that the development of quality educational software was "critical to the continuing and increasing use of computers in schools." (p. 41) She noted that software evaluation articles usually focused on curriculum design. She cited the work of Wade (1980), Gagne and Briggs (1974), Cohen (1983b), and Gagne, Wager, and Rojas (1981) as giving guidelines for educational software design. But, she cautioned, there must be guidelines for developing standards of technical quality. She recommended the use of the NEA Educational Computer Service guide for this purpose. She included an abbreviated version of this guide for the reader's use. She concluded by stating that a "comprehensive approach to software development will ensure its quality." (p. 50)

Gagne, Robert M. and Leslie J. Briggs. Principles of Instructional Design. New York: Holt, Rinehart, and Winston, 1974.

In the chapter that dealt with the events of instruction, Gagne and Briggs listed the events that "make up instruction for any single performance objective." (p. 135) These events were applied to all types of learning outcomes. They were: "gaining attention, informing the learner of the objective, stimulating recall of prerequisite learning, presenting the stimulus material, providing learning guidance, eliciting the performance, providing feedback about performance correctness, assessing the performance, enhancing retention and transfer." (p. 135) By following these events, a designer would produce a lesson that would be more effective for learning.

Wade, T. E., Jr. "Evaluating Computer Instructional Programs and Other Teaching Units." Educational Technology, 20.11 (November 1980): 32-35.

Wade took the work of Gagne and Briggs (1974) and stated how it could be applied to instructional programming. He suggested using their "instructional events" (Gagne and Briggs 1974: p. 135) to provide a framework for designing an instructional computer program. He further stated that not every component needed to be included in every program. A program could be "part of a larger learning unit . . . (and) its specific purpose might be only motivation, testing, or drill." (p. 32) He also listed "the characteristics of a good learning situation: (1) the learning must be right, (2) the learner must be ready, (3) the learning needs to be managed or facilitated, (4) the assimilation must be practicable, and the learning must be efficient." (pp. 33, 34) He finally stated that most instructional programs were not meant to be completely self-contained and so would not have to provide all the elements of a good learning situation.

Gagne, Robert M., Walter Wager, and Alicia Rojas. "Planning and Authoring Computer-Assisted Instruction Lessons." Educational Technology, 21.9 (September 1983): 17-25.

Gagne, Wager and Rojas proposed a system for improving the traditional method of designing a computer-assisted lesson. They did not address the area of feedback, but stressed the improvement of the text, to design it according to the type of learning outcomes desired. These outcomes were classified as: "(1) verbal information; (2) intellectual skills; . . . (3) cognitive strategies; (4) motor skills; and (5) attitudes." (p. 17) Those who would design CAI software were advised to follow the "events of instruction." (Gagne and Briggs 1974) The major point made by the guidelines was that designers of CAI instruction should attend to all nine of these events, rather than simply to two or three (such as questions and feedback).

Cohen, Vicki, Blum. "Criteria for the Evaluation of Microcomputer Courseware." Educational Technology, 23.1 (January 1983b): 9-14.

Cohen stated that developing standards for evaluating courseware has been a problem, since there were no accepted criteria as to what comprised an effective program. A review team at Teachers College, Columbia University, New York, developed minimal and desired realistic standards. The team followed the recommendations of Roblyer (Roblyer 1981: pp. 48-50) and listed those attributes that were generic to all instructional design and necessary for microcomputer courseware. Important attributes for microcomputer courseware were: "the role it played in the curriculum, . . . the mode of interaction it employed, . . . the way a student was sequenced through the content, . . . the ease of reading and the appropriateness of the graphics it had, . . . the correct use of prompts and cues, . . . and the appropriate use of its interaction with the student in terms of feedback and learner control." (pp. 10-13)

Roblyer, M. D. "When Is It 'Good Courseware?' Problems in Developing Standards for Microcomputer Courseware." Educational Technology, 21.10 (October 1981): 47-54.

Following the introduction of microcomputers into schools, there was "an amazing amount of materials (produced) which . . . do not meet very basic standards of instructional tools, or do not make good use of the unique capabilities of the medium, or both." (p. 47) One of the problems in developing standards was that there were disagreements as to what ideal courseware should be. Most criteria that were used have been derived from the reviews of courseware already produced. These reviews have not looked at the models of mainframe systems which were fine examples of what CAI should be. Roblyer compared one model which was student-controlled with tailored feedback and much graphics and animation, with another which was machine-controlled, with standard feedback and few graphics or animation. There has been disagreement as to which was the more effective method. Roblyer stated that what was needed were standards "flexible enough to allow for variations in instructional approach . . . yet stringent enough to rule out materials with design and/or presentation flaws which will hamper learning and ease of use for teachers." (p. 50) She recommended that a team produce the courseware; an instructional designer, a content expert and a programmer. After the courseware was developed, a review team made up of the same kinds of experts should review the package.

Golas, Katherine C. "The Formative Evaluation of Computer-Assisted Instruction." Educational Technology, 23.1 (January 1983): 26-28.

Golas defined formative evaluation as "the process of collecting empirical data during the development of instructional materials to ascertain if they need revision." (p. 26) She described the special considerations needed to evaluate CAI and offered her recommended approach to conduct formative evaluation of CAI. She suggested that the first evaluation "should consist of frames, written by the designer of the program, on paper." (p. 27) This should be tried out with at least one person of the group to which the lesson was targeted. A second trial should have a one-to-one run through with a student giving comments and his performance noted. The next trial should be a small group of three students with an evaluator watching to collect data and comments. Golas felt that a full-scale field test would be very expensive and the cost might outweigh the value of the information collected. If conducted, however, a large field-test could show management problems a teacher might later face. Golas also stated that many programs were produced with no formative evaluation at all, but it was worth the time and cost to produce an effective program.

Cohen, Vicki Blum. A Learner-Based Evaluation of Microcomputer Software. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada: ERIC Document Reproduction Service, (1983a), ED 233 693. (Microfiche)

Cohen reported on an eight-month project to evaluate microcomputer courseware that was being marketed for school use. The courseware was evaluated by a team that consisted of an expert in the subject matter, an expert in instructional design, and a practicing teacher. After the team had evaluated the materials, the courseware was tried out on learners, and their input was used to "verify or refute the findings of the evaluation team." (p. 5) The team compiled the attributes they felt were necessary for evaluation. They used four sources to assemble the attributes: "a review of the literature in areas of computer-assisted instruction, subject matter experts who were consulted on design of courseware, a survey of existing instruments used to evaluate instructional software, and (their) previous experience in analyzing instructional materials." (p. 12) This study followed one that had been conducted a year earlier, where no practicing teachers or learners were involved. This was perceived as a weakness in the first study and was corrected in the second study.

Steffin, Sherwin A. "A Suggested Model for Establishing the Validity of Computer-Assisted Instructional Materials." Educational Technology, 23.1 (January 1983): 20-22.

Steffin outlined the problems faced by software publishers in providing instructionally valid computer-assisted instruction. Unlike textbooks, purchases of audio-visual materials often were selected by a classroom teacher or a media director. This one evaluator must decide whether or not to purchase the software, utilizing criteria which were much more poorly defined than those for choosing textbooks. Steffin then suggested four major concerns for the evaluation: "(1) technical quality; (2) content accuracy; (3) instructional quality; (4) learner type." (p. 20) The procedure for evaluation should include "pre-screening, . . . classifying the material with respect to the curriculum, . . . reviewing the ratings of independent specialists, and . . . identifying the programs' applications for their effectiveness." (p. 20) He further stated that the "essential component of any instruction . . . is the degree to which measurable changes, modifications, or additions to the learner's behavior may be identified." (p. 21) The software should be carefully evaluated using stated objectives, criterion referenced tests, and the use of gain scores to measure any differences in performance.

Roblyer, M. D., and F. J. King. "Directing the Course of Educational Computing Why Common Sense Isn't Enough." Electronic Learning, 2.8 (May/June 1983): 22-24.

Roblyer and King stated that there has been an enormous movement to put computing into education, but there has been little scientific research to prove that this has improved learning. Most of what we have seen so far has come from common sense beliefs and not research studies. Research has been unpopular because; "it is expensive, . . . it is often regarded as impractical and unproductive, . . . it is difficult, . . . the products sell anyway, . . . and many computing enthusiasts feel that some aspects of instructional effectiveness are simply not measurable." (p. 22) The authors called for research to indicate effectiveness in discovery learning and problem-solving courseware. They said we need studies on why CAI works, and what implementation procedures make effective or ineffective use of the computer. Products should be field-tested, and researchers need to look at what aspects of our educational system "are most amenable to the effective use of instructional computing." (p. 24) Common sense was not enough because it was unreliable.

Watt, Molly, "Making a Case for Software Evaluation." The Computing Teacher, 9.9 (May 1982): 20-22.

Watt compared her experiences with using technology such as a film projector, tape recorder, and camera twenty years ago, with today's technology, the microcomputer. As the earlier technology became commonplace in the curriculum, Watt stated, so would the computer. Now, teachers were faced with choosing software, and many were uneasy and unsure about how to decide what to buy. It was very important for teachers to understand the unique capabilities of the computer. It could be interactive with a student and could provide graphics to enhance learning. "It can access information directly, rather than sequentially. It performs calculations with incredible speed and reformats according to new commands almost instantly." (p. 21) "By being involved with the instructional use of microcomputers from the beginning, we can explore their learning and teaching potential and begin to influence the development of high-quality software that will help realize that potential." (p. 22)

Jay, Timothy B. "The Cognitive Approach to Computer Courseware Design and Evaluation." Educational Technology, 23.1 (January 1983): 22-26.

Jay stated that elements which must be considered in the development of microcomputer courseware were: "memory and attention demands," (p. 23) . . . "language or text characteristics, graphics and visual processing," (p. 24) . . . and "a cognitive model of the user." (p. 25) Pertaining to memory; since we were limited in the amount of information we could deal with at one time, only one idea at a time should be presented on a screen. "An idea is probably about one or two sentences in length." (p. 23) More time was needed if the idea were difficult. The courseware should aim toward the concrete rather than the abstract. Because memory was improved by the use of graphics; color, graphic descriptions, pictures, maps, and drawings, were all helpful to enhance learning. Finally, since everyone liked to know the results of his performance, feedback should: be personal, give hints, tell the user his score, reward him for correct responses, and avoid frustrating him.

Steinberg, Esther R. "Reviewing the Instructional Effectiveness of Computer Courseware." Educational Technology, 23.1 (January 1983): 17-19.

Steinberg stated that complete courseware reviews should contain different aspects: "administration; . . . implementation; . . . and . . . instruction." (p. 17) Administration contained items such as memory requirements, cost, etc. Implementation gave information on the amount of teacher-time needed, availability of student reports, etc. Most important was the instructional effectiveness of courseware. In the courseware review should be: "the suitability of the lesson for the target population, . . . the quality of the use of computer features such as feedback, color, sound, and graphics, . . . and observation of student users." (p. 18) A thorough evaluation should include at least one person experienced in teaching the content matter and one who has a knowledge of CAI and human-machine interaction.

Douglas, Shirley, and Gary Nieghts. A Guide to Instructional Microcomputer Software. Harrisburg: Pennsylvania Department of Education, n.d.

Douglas and Neights assembled an extremely helpful book to guide the evaluator, even a novice, through the software selection process. They clearly defined early considerations, such as checking available hardware to make certain there was compatibility between hardware and intended software. They pointed out that many areas of consideration for instructional software were the same as for other forms of instructional media, i.e., "Are grade levels, target populations, and prerequisite knowledge levels identified? Are instructional objectives stated?" (p. 4) They explained to the evaluator other areas of consideration: validation; correlation with textbooks; instructional strategies; and design features which went to make up a careful review of a program. They included appendixes which listed user's groups, software libraries, reference materials, and a glossary of terms. A sample evaluation form was included.

Eldredge, Bruce, and Kenneth Delp. "How to Evaluate Educational Computer Programs." Media and Methods, 17.7 (March 1981): 4 et passim.

Eldredge and Delp discussed four types of educational computer programs: computer-assisted instruction, computer-managed instruction, computer games, and computer simulations. They stressed the importance of the diagnostic function for CAI and described two types of programs, linear and branching. In CMI, flexibility was critical for the user. The program must be adaptable to the user's needs and available hardware must be a consideration in the user's choice. Objectives, both stated and unplanned in computer games should be defined. Simulations which imitated real-life situations should "match the maturity of the student users and strike a balance between real-life and significant unpredictability." (p. 15)

Watt, Dan. "Computer Evaluation Cometh." Popular Computing, 3.9 (July 1984): 91, 94.

Watt stated that we do not have hard data to know exactly what the computer was "doing to the teaching and learning processes." (p. 91) Developers have resisted allowing evaluation while they were field-testing new projects. They were afraid to have teachers and students concerned about being tested while they tried a new product. Schools should be monitoring the results of their own programs to give them a basis for evaluation. They should look at "curriculum goals and objectives; staff training and development; the use of computer-related materials; . . . and student progress." (p. 94) A particular problem relating to computer education was that goals and objectives kept changing. Watt concluded by saying that we should be doing some systematic planning for evaluation, but "we may have to live with some unanswered questions for some time." (p. 94)

Rose, Stephan A., et al. "Social Studies Microcomputer Courseware Evaluation Guidelines." Social Education 48.7 (November/December 1984): 573-576.

Stephan Rose chaired a committee which developed guidelines to identify courseware that achieved objectives and goals related to social studies. Although there were many generic evaluation forms available, these forms did not focus on the specific goals of the social studies. There were two different aspects that the committee addressed. First, a particular set of materials should be appropriate for use in the social studies classroom. Second, educators should look at technical and instructional issues. They organized a form around three areas; "knowledge, skills, and values." (p. 573) They included a comprehensive checklist that addressed those issues with which the evaluator of social studies instructional courseware should be particularly concerned.

Savitsky, David. "A Publisher's Guidelines for Educational Development." Educational Technology, 24.4 (April 1984): 45.

Savitsky, the president of a software publishing company, outlined his company's guidelines for developing software. The company wrote its own guidelines because there were no educational standards generally accepted by the software industry today. He listed ten guidelines. Each program must: "(1) contain new content or skill-producing strategies, . . . not drill and review material; . . . (2) be motivational, offer some challenges, and be fun; . . . (3) contain no violence or aggression; . . . (4) have clearly-stated objectives; . . . (5) be rigorously field-tested; . . . (6) provide the learner with ease of control; . . . (7) allow the teacher to monitor and review the learner's activities; . . . (8) have clear printed documentation; . . . (9) be accurate in language usage; . . . (10) be free from sarcasm and derogatory remarks." (p. 45)

Carter, Jeri. "Instructional Learner Feedback: A Literature Review with Implications for Software Development." The Computing Teacher, 12.2 (October 1984): 53-55.

The developers of software have not put the results of learning research into their software packages. Carter examined feedback, one of the factors, that could influence learning. Feedback helped the student learn by providing corrective or evaluative information after the student responded to a stimulus. "Feedback has four characteristics: function, timing, schedule, and type." (p. 53). The main function of feedback should be to provide information rather than to motivate. Students learned higher cognitive level information better when the feedback was delayed, and this delay seemed to help them retain new knowledge. If the feedback were immediate, it seemed to benefit learners who were engaged in rote memory tasks. The most important aspect of feedback was that it identified and corrected errors. Carter recommended that: "(1) feedback should function to provide information relevant to previous responses . . . (2) the primary importance with respect to schedule of feedback is to identify errors . . . (3) if the CAI deals with higher cognitive level information, the timing of the feedback should have a delay and provide information for correction of errors . . . (4) if the CAI deals with lower cognitive level information, the timing of the feedback should be immediate and should probably include knowledge of the results." (p. 54)

Steffin, Sherwin A. "Come In and Play with Me Computer Simulations: A Key to Divergent Thinking." Media and Methods, 18.2 (October 1981): 12-13.

Steffin discussed the fact that computer simulations were an ideal means to foster divergent thinking. To apply divergent thinking to intellectual problems, several conditions needed to be met. These conditions included: "rigorous criteria . . . to distinguish acceptable from unacceptable solutions; strong, positive feedback as the players' answers approach the 'ideal' response; . . . and immediate feedback giving the learner his status in reaching a solution." (p. 12) Since simulations in the classroom setting, needed considerable time and attention from the classroom teacher and required great patience and flexibility, a programmed computer would be well suited to do this task. Steffin encouraged teachers to establish criteria for evaluating simulation activities as a teaching tool.

Kansky, Bob, William Heck, and Jerry Johnson. "Getting Hard-Nosed About Software: Guidelines for Evaluating Computerized Instructional Materials." Mathematics Teacher, 74 (November 1981): 600-604.

Kansky, Heck, and Johnson stressed that evaluating software was different from textbooks because there was much less teacher and student control over manipulating the lesson on the computer. There was a need for new procedures to aid educators in evaluation and selection, for no industry standards yet existed. The authors suggested ways of making decisions: previewing, reading descriptive information from the vendor, and documentation. Finally, they gave steps to lead the reviewer through the process of making an evaluation: "seeing how a program 'flows', . . . executing the program as both successful and unsuccessful student users would, . . . using established criteria, and . . . comparing observations with claims made by the vendor." (p. 602) They also gave criteria from the user's point of view: "clear and easily recalled directions, and . . . constant dialogue between program and user." (p. 603)

Dearborn, Donald E. "A Process for Selecting Computer Software." NASSP Bulletin, 66.1 (September 1982): 26-30.

Dearborn defined four types of computer-assisted instruction: drill and practice, tutorial, simulation, and problem solving. He described the process by which Alexandria, VA purchased software. The school system established a Computer Technology Council. The Council reviewed and recommended purchases. All members utilized an evaluation instrument which addressed: software correlation with documented curriculum; evaluator's impressions of content, instructional, and technical qualities; and recommendations for purchases. Steps for evaluating were summarized: 1. read software reviews, 2. analyze vendor's descriptions, 3. subscribe to program evaluations, 4. include an instrument for evaluation, and 5. assure program correlation with curriculum.

Truett, Carol. "Field Testing Educational Software: Are Publishers Making the Effort?" Educational Technology, 24.5 (May 1984): 7-12.

Truett's study was designed to determine what field testing and other methods of evaluation were being used by educational software publishers during the formative stage of educational software development. Four hundred six software producers/publishers were sent questionnaires to attempt to determine the prevalence of field testing, the number of students and teachers participating, and the location of field testing. Additional questions concerned the evaluation criteria used, if documentation included the results of field testing, and the publisher's opinion of field testing. The return rate was low (13.8 percent). Seventy percent of the responders did do field testing, but for the majority of them (51.8 percent), it meant using six or fewer teachers in local schools with 50 or fewer students. The major indicator (47.7 percent) of effectiveness was teacher evaluation rather than student achievement. Most (85 percent) did not include results in their documentation, although a majority (58.2 percent) responded that they considered field testing to improve the marketability of their product.

Robinson, Jack E. "Can 'Soft' Data Be Used to Evaluate the Effectiveness of Educational Technologies?" Educational Technology, 23.6 (June 1983): 17-21.

Robinson stated that under certain circumstances the perceptions of students toward a teaching method's usefulness might be more accurate than presumed. Data came from Old Dominion University where faculty used evaluation forms of their choice to find if "signigicant or non/significant increase in student achievement was observed and whether students perceived materials to have been beneficial or not." (p. 17) The data showed a correspondence between actual achievement results and student perception. Robinson cited Pepper (Pepper, 1981, p. 261) who demonstrated the constructive use of student feedback to develop a course text. He stated that the data supported the idea "that simply asking students about the effectiveness of an instructional procedure provides reliable and valid information for making decisions about the utility of a particular innovation." (p. 18) He asked "if a sizeable collection of soft data, though not a substitute for controlled analysis, might not be sufficient for the development of instructional materials." (p. 21)

Pepper, Jeff. "Following Students' Suggestions for Rewriting a Computer Programming Textbook." American Educational Research Journal, 18.3 (Fall 1981): 259-269.

This study discussed two experiments in technical textbook design. In the first experiment, excerpts from two existing computer programming texts were given to a group of college students. "Comprehension of both texts was found to be poor, and surprisingly, the subjects overwhelmingly preferred the verbose and poorly written text over the concise and well written one." (p. 261) It was concluded from the students' comments that they were looking for an easy-to-read text with lots of examples. In the second experiment a new chapter was written in this easy-to-read style and it was found that the students' comprehension improved substantially, and they also liked the new material better than either of the first two texts. The conclusion drawn was that since comprehension and attitude improved, the students' perceptions were correct.

Signer, Barbara. "How Do Teacher and Student Evaluations of CAI Software Compare?" The Computing Teacher 11.3 (October 1983): 34-36.

Signer initiated this study because she could find no studies that compared the perceptions of students and teachers with CAI courseware. She designed a study to compare these different perceptions. Three forms were used: The Signer Student Software Evaluation Checklist; The Signer Teacher Software Questionnaire; and Guidelines for Evaluating Computerized Instructional Materials from the National Council of Teachers of Mathematics. The students completed the first form, and the teachers completed the other two. Teachers' ratings were higher than students' for "instructional and motivational value." (p. 35) Both teachers and students "focused on motivation and visual qualities (graphics) for program strengths." (p. 35) Her conclusions were that students and teachers perceived the same software differently. Students were stronger critics than teachers. She recommended more extensive field testing in the schools to use student perceptions to improve the quality of software.

Cohen, Vicki Blum. Evaluating Instructional Software for the Microcomputer. Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.: ERIC Document Reproduction Service, (1982), ED 216 704. (Microfiche)

A study was conducted at Columbia Teachers College to develop criteria with which to evaluate commercial microcomputer software. A team of eight analysts evaluated the software. Their findings were that most of the "large commercial courseware programs on the market are arithmetic programs which stress a drill and practice application and are designed to be used in elementary schools. . . . The major emphasis is the recall of previously learned facts . . . and they do not stress higher-order skills. . . . The user is granted very little control . . . and most feedback does not remediate wrong answers." (p. 12)

Cohen, Vicki Blum. "What Is Instructionally Effective Microcomputer Software?" Viewpoints in Teaching and Learning 59.2 (Spring 1983c): 13-27.

Cohen stressed that evaluators should "examine the statement of objectives, . . . the organization of the material, . . . the method used for directing the learner, . . . and the data given to ascertain if the objectives have been achieved." (p. 14) She pointed out that even if a program met the criteria, the ultimate question was, "Does the learner like the program and will he learn anything from it?" (p. 16) Cohen further stated that during the evaluation process it was important to look at the mode of interaction, i.e., drill and practice, tutorial, simulation, etc., and the quality of the feedback. It was also important to examine the amount of control the learner had. The technical qualities of graphics and formatting should not be overlooked. The capability of the microcomputer to have animation was often ignored, and was one of its finest attributes.

SUMMARY

Elliot, Ingersoll, and Smith reported that while enthusiasm in the educational community was evident for the use of the computer, the general feeling was that the software, which contained the data and exercises students needed to work on the computer was "dull, unimaginative, of questionable soundness, . . . and many programs are little more than electronic flashboards." (Elliott, Ingersoll, and Smith, 1983, p. 20)

To counter the acquisition of this kind of software, Cory conceptualized a model in which the selection of software was based on well thought-out plans, and the evaluation and purchase of software shared importance with the purchase of hardware. (Cory, 1983, p. 15)

Many schools have felt the need for systematic evaluation. The DISC model for software evaluation used in Michigan, created a network of teachers trained in software evaluation. (Rose, 1983) In Utah, the SECTOR project used teams to report in narrative form about the quality of the software they reviewed. (Allard and Reid, 1983)

The literature emphasized a wide difference of opinion about the evaluation of educational microcomputer software. Caldwell (1984) complained that "few of the criteria used to evaluate . . . software have been validated in any sort of well-conducted research." (p. 17) Kohl (1984) took a dissenting view, and stated that educators were searching for too exact criteria, and that what was truly needed was only good judgement

and sensitivity. (p. 33) Fetter (1984) stressed that it was the users' responsibility to evaluate programs critically and then to inform the producers of their findings. (p. 19)

Manning pointed to the low quality of educational microcomputer software when she described catalogs that had "glowing . . . descriptions that belie programs that are disappointing in the classroom." (Manning, 1985b, 1D) She additionally reported "that only 10 percent of the programs listed" (by a nationally known evaluating service), "have been evaluated in depth . . . and only 20 to 25 percent of the programs have been evaluated by anyone." (Manning, 1985a, 3D)

Clearly educators were searching for a way to identify and purchase the highest quality educational software possible.

There has been research concerning the use of computers in the classroom setting for the past twenty years. The research has examined achievement in subject matter, attitudes of students, and use of instructional time. (Fisher, 1983, p. 82)

The effectiveness of computer-assisted instruction in mathematics and beginning reading was examined by Atkinson and Suppes. (1968) They found that CAI made no difference with average ability students, but that it resulted in a positive gain for students of below average ability. (p. 141)

The following year, Suppes and Morningstar (1969) published the findings of studies conducted in both California and Mississippi on a drill and practice program in elementary mathematics. They also reported results from a study of a beginning Russian

language course at Stanford University. In the mathematics study, as well as the language study, the results showed a significant gain for those students who received computer-assisted instruction. (p. 349)

Three years later, Vinsonhaler and Bass (1972) confirmed these earlier findings, when they reported a summary of ten studies that had been conducted on drill and practice computer-assisted instruction in mathematics and language arts at the elementary school level. They noted that the CAI did not stand alone, but supplemented traditional classroom instruction. (p. 31)

Dence examined the findings of seventeen studies conducted during the late sixties and in the seventies. She noted that "the major focus was on subject matter and global comparisons of CAI to traditional instruction." In the studies where subject matter was a variable, CAI was found to be effective in the areas of foreign languages and the sciences. (Dence, 1980, p. 51)

Burns and Bozeman (1981) conducted a meta-analysis of forty studies to integrate findings relative to the effectiveness of computer-assisted mathematics instruction in elementary and secondary schools. Their conclusions were that CAI was significantly more effective for high-achieving students and low-achieving students. Students of average level were not significantly effected. (p. 37)

Yates also indicated that the early research on computer-assisted instruction gave "rather strong evidence for the effec-

tiveness of CAI over traditional instruction where effectiveness is measured by standardized achievement tests." He remarked that drill and practice courseware has had a bad reputation due to much poorly designed software rushed into the marketplace. However, because it has been proved to be effective, educators should consider CAI drill and practice as a viable option as an instruction method. (Yates, 1983, p. 55) Fisher called for further research on the effectiveness of the use of computers on student attitudes and achievements. He stated that even though anecdotal records seemed to indicate that students felt more positive about themselves and school after working with computers, more scientific research should be conducted on "attitude and self-image results, behavioral results, and social changes." (Fisher, 1984, p. 26)

The study conducted by Steele, Battista, and Krockover (1983) indicated that students who received CAI instruction in mathematics, did show significant gains in the affective domain, even though no significant difference was found in achievement in the subject matter. (p. 300)

Ten of the fifty-one studies in the meta-analysis conducted by Kulik, Bangert, and Williams (1984) were analyzed in terms of student attitudes. They found that student attitudes were more positive in classrooms using computer-based instruction. (p. 24)

Another important aspect of the effectiveness of computer-assisted instruction was that of the use of instructional time. Kulik, Kulik, and Cohen (1980) stated that the greatest finding

in their meta-analysis of fifty-nine studies of computer-based college teaching was the saving of instructional time. (p. 538)

Orlansky looked at students in the military. While achievement in subject matter was not significantly raised, the median time saving was about 30 percent. He stated that this effectiveness in terms of time, could prove extremely important not only to the military, but also to any business which was paying for time to train workers. (Orlansky, 1983, p. 60)

In an overview of the research, Bracey pointed out that even though Kulik (1984) found that computer-assisted instruction was effective when compared to traditional instruction, no attempt was made "to evaluate the quality of the . . . materials used." (Bracey, 1982, p. 53)

Forman came to the conclusion that despite the fact that there were unknowns and questions about the use of computers in the instructional setting, schools should "concentrate their efforts on areas where CAI has proven itself both effective and cost effective." (Forman, 1982, p. 49)

According to Gold (1984) much of the literature pertaining to the quality of educational software focused on curriculum design. (p. 42) She noted that Wade (1980) cited the work of Gagne and Briggs in which they listed the characteristics of instructional design. These events were: "gaining attention, informing the learner of objectives, stimulating recall of prerequisite learning, presenting the stimulus material, providing learning guidance, eliciting the performance, providing feedback

about performance correctness, assessing the performance, and enhancing retention and transfer." (Gagne and Briggs, 1974, p. 135) Wade applied these characteristics to computer program design and also stressed that for a good learning situation; the learner must be the right one, ready to learn, with efficient, well-managed instruction. (Wade, 1980, pp. 33, 34)

Gagne, Wager, and Rojas expanded on these concepts and discussed the writing of educational software in terms of the learning outcomes desired. They classified outcomes as verbal information, intellectual skills, cognitive strategies, motor skills, and attitudes. (Gagne, Wager, and Rojas, 1981, p. 17)

Cohen followed the recommendations of Roblyer (Roblyer, 1981, p. 54) and assembled a team made up of experts in instructional design, content, and programming. This team listed attributes that were general to all courseware and those that were necessary to computer courseware in particular. Among the latter were: "the role it played in the curriculum, the mode of interaction, the effectiveness of the text and graphics, and the appropriateness of interaction with the user." (Cohen, 1983b, pp. 10-13)

Golas (1983) examined the formative evaluation stage of designing microcomputer software, and she stated that producing an effective program was well worth the time, cost and effort of conducting formative evaluations. (p. 28) Cohen (1983a) agreed with Golas, particularly on the point that learners should be involved in the formative evaluation process. (p. 5)

Steffin suggested four major concerns for evaluating educational software: "technical quality, content accuracy, instructional quality, and learner type." He stressed that changes in terms of behavioral outcomes should be identified and if possible measured. (Steffin, 1983, p. 20)

Roblyer and King lamented the fact that so little research has focused on the evaluation of microcomputer software. They said that the common sense approach to using computer software in schools was not good enough. Many times common sense has proved unreliable, so studies should be conducted to prove why computer-assisted instruction works and what procedures make effective use of the computer. (Roblyer and King, 1983, p. 24)

SURVEY OF SELECTED MICROCOMPUTER SOFTWARE EVALUATION FORMS

A survey of twenty-two selected forms pertaining to the evaluation of educational microcomputer software was compiled during the course of this study. (See Appendix A.) Questions asked of evaluators were listed. A matrix was constructed, (see Appendix B.) and the questions were then ranked in the order of the number of times they occurred on these forms. (See Appendix C.)

The most frequently asked question was directed toward the graphics, sound, and color enhancement of a software program. It was mentioned as an attribute on twenty-one of the twenty-two forms (95 percent). Watt (1983) emphasized that graphics could enhance learning and were a unique capability of the computer. (p. 21)

Jay asserted that the use of graphic descriptions, pictures, maps, and drawings improved memory and therefore would be helpful for learning. (p. 23)

He also stressed the need for clear, concise screen displays, since the learner was limited in the amount of information he could deal with at one time. (Jay, 1983, p. 23) Seventeen (77 percent) of the forms examined asked if the display were clear and easily read. Although most of the forms asked about sound enhancement, it was surprising that only nine (41 percent) asked if it could be turned off. In a classroom situation, this could be extremely important, if the teacher did not want noise to distract students otherwise occupied.

Steinberg (1983) called for the evaluator to decide if the program were appropriate for its target audience as did Douglas and Neights. (n.d.) Nineteen of the evaluation forms (86 percent) asked for identification of the intended grade level(s), but only eight (36 percent) asked if it were appropriate for that audience. Three forms (14 percent) did expand on the target audience question by asking for a designation of remedial, on grade level, or enrichment.

The concern with stated objectives was reflected in the evaluation forms surveyed, for seventeen of the twenty-two (77 percent) asked if the objectives and goals were stated. Eldredge and Delp (1981) discussed the need for the objectives of a computer program, both stated and implied, to be defined. (p. 4) Watt (1984) called for schools to examine their own curriculum objectives to give them a basis for evaluation. (p. 94) Rose

(1984) observed that many generic forms did not address the specific goals and objectives of social studies courseware. (p. 573) Savitsky (1984) listed clearly stated objectives as one of his company's ten working guidelines. It was interesting to note that only eleven forms (50 percent) asked if the objectives were achieved.

Fifty-nine percent (13) of the forms addressed the question of feedback. Most of the forms asked if the feedback were effective. This question seemed imprecise. Carter (1984) emphasized the importance of this attribute and pointed out that feedback was one of the factors that could influence learning. (p. 53) She stressed the importance of the timing of feedback and emphasized that the most important aspect of feedback was that it identified and corrected errors. (Carter, 1984, p. 54) Only two forms (9 percent) addressed the question of remediation of errors. Steffin added another criterion for feedback in simulations. He called for very positive feedback as the learner involved in a simulation approached the correct response. (Steffin, 1981, p. 12) This attribute was not noted on any form.

Kansky, Heck, and Johnson (1981) suggested searching for technical problems by running the program as both the successful and unsuccessful student would. (Kansky et al., 1981, p. 602) Dearborn (1982) also advised looking at the technical quality of the program. Ten (45 percent) of the surveyed forms asked specifically if the program were free from technical errors and if there were safeguards against crashing during operation. Ten

(45 percent) included a question about safeguards from crashing during operation. It was amazing that the question, "Does it work?" was not on every form.

A number of authors spoke to the question of field testing and getting student input during the developmental stages of a computer program. Truett's study (1984) showed that 85 percent of publishers did not include this information in their documentation. (p. 9) Robinson (1983) and Pepper (1981) asserted that using students' perceptions of instructional materials provided reliable and valid information about the effectiveness of an instructional procedure. Signer (1983) concluded in her study that students and teachers perceived the same software differently. Nine of the forms surveyed (41 percent) asked if field testing were reported in the documentation. This attribute did not appear to have received the attention it should have. Student imput seemed to be overlooked.

A clear majority (77 percent) of the forms asked for a designation of the type of program, i.e., drill and practice, tutorial, simulation, etc. Cohen's study found that most large commercial programs stressed drill and practice and did not grant the user very much control. (Cohen, 1982, p. 4). Just five forms (23 percent) asked if there were active involvement of the user.

One of the most surprising statistics in the survey was that only two forms (9 percent) asked specifically about the good use of animation. Cohen confirmed the lack of attention to this

capability of the computer. She said that it was often overlooked, even though it was one of the computer's finest attributes. (Cohen, 1983c, p. 21)

CONCLUSION

Is there a need for evaluating educational microcomputer software?

The research indicated that clearly there was a need for evaluation of the software schools select for purchase. Whether the process of evaluation was implemented through a school-wide system using checklists, or small groups using narrative reports, educators were searching for some method of selecting high quality software programs. Educators would like the process to be both efficient and accurate. The industry has set no standards for itself, and teachers are faced with a staggering amount of microcomputer software programs on the market. If teachers are unable to find a method of selecting well designed and educationally sound materials, the future of the computer in the classroom may not be as bright as it has been painted.

Is computer-assisted instruction effective?

The answer to this question must be a qualified , for the research reported that it was effective in some areas, such as foreign languages and mathematics, and with certain kinds of learners. It was found to foster positive attitudes toward learning and school. It was found to be effective in terms of

saving instructional time. We do not know if computer programs which deal with discovery learning or problem solving are effective, because research has not given us the answer yet. Even though the quality of the software was not addressed in the studies, we do know that computer-assisted instruction can be effective when integrated into the curriculum, if the setting, the conditions, and the learners are right.

What criteria should be used?

Many of the readings about evaluation of software were directed toward the design of the software. The framework set up by instructional designers gave a plan for implementing a lesson in an effective manner. Gagne and Briggs' classic design was referred to many times as the ideal construct of a computer lesson. (Gagne and Briggs, 1974, p. 135) But in addition to the design of the lesson, there were technical standards which were extremely important. Software programs should be reliable and run without technical problems. The unique capabilities of the microcomputer should not be overlooked, and the graphics, sound, and color attributes should be used to their potential. The literature said rather clearly that what was needed was a merging of educational standards with the new technology. If accomplished it could prove extremely effective.

The survey of selected forms pointed up the fact that solid criteria for evaluation have not been established. Some of the forms were extremely technical and would take an experienced

professional several hours to complete when reviewing a package. Others, which were less complex, could be completed by a novice evaluator in much less time, but often did not cover all the critical issues that should be examined. The questions often were imprecise, and all questions were weighted equally. The survey of evaluation forms highlighted the fact that there is a need for accepted standards that can be applied to software programs. The literature said that the educational community was aware of the need for research to establish criteria to aid teachers in choosing high quality software. When results of this research are reported, teachers will have a solid foundation of standards on which to base decisions when selecting microcomputer software to add to their curriculum.

RECOMMENDATIONS

It is recommended that:

1. More research be directed toward isolating the attributes that make up an effective microcomputer software program.

2. Forms for evaluation contain weighted criteria, as certain characteristics may be more critical to the effectiveness of a program than others.

3. Evaluation forms be developed for the classroom teacher, that cover the critical attributes of a program, but are not so technical as to be threatening.

4. Schools encourage their teachers to become knowledgeable in the area of the evaluation of educational microcomputer software.

BIBLIOGRAPHY

Allard, Kim, and Bob Reid. "Courseware Evaluation: The SECTOR Project." Educational Computer Magazine, 3.2 (March/April 1983): 22-26. (11, 35)

Atkinson, Richard C., and Patrick Suppes. An Automated Primary-Grade Reading and Arithmetic Curriculum for Culturally Deprived Children. Stanford, CA: ERIC Document Reproduction Service, (1968), ED 023 773. (Microfiche) (14, 36)

Becker, Henry Jay. School Uses of Microcomputers, Issue No. 1. Baltimore MD: The Johns Hopkins University, 1983. (1)

Billings, Karen A., and David Moursund. Are You Computer Literate? Portland, OR: Dilithium Press, 1979. (4, 5, 6, 7, 8)

Bracey, Gerald W. "Computers in Education What the Research Shows." Electronic Learning, 2.3 (November/December 1982): 51-54. (20, 39)

Burns, Patricia Knight, and William C. Bozeman. "Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship?" Educational Technology, 21.10 (October 1981): 32-39. (16, 37)

Caldwell, Robert M. "Evaluating Microcomputer Software in the English Language Arts." English Education, 16.1 (February 1984): 14-21. (12, 35)

Carter, Jeri. "Instructional Learner Feedback: A Literature Review with Implications for Software Development." The Computing Teacher, 12.2 (October 1984): 53-55. (30, 43)

Cohen, Vicki Blum. Evaluating Instructional Software for the Microcomputer. Paper presented at the Annual Meeting of the American Educational Research Association, New York: (1982) ERIC Document Reproduction Service, ED 216 704. (Microfiche) (34, 44)

_____. A Learner-Based Evaluation of Microcomputer Software. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, Canada: (1983a) ERIC Document Reproduction Service, ED 233 693. (Microfiche) (24, 40)

_____. "Criteria for the Evaluation of Microcomputer Courseware." Educational Technology, 23.1 (January 1983b): 9-14. (23, 40)

_____. "What Is Instructionally Effective Microcomputer Software?" Viewpoints in Teaching and Learning, 59.2 (Spring 1983c): 13-27. (34, 44, 45)

Cory, Sheila. "A Four-Stage Model of Development for Full Implementation of Computers for Instruction in a School System." The Computing Teacher, 11.5 (November 1983): 11-16. (10, 35)

Dearborn, Donald E. "A Process for Selecting Computer Software." NASSP Bulletin, 66.1 (September 1982): 26-30. (31, 43, Appendix A)

Dence, Marie. "Toward Defining the Role of CAI: A Review." Educational Technology, 20.11 (November 1980): 50-54. (16, 37)

Dennis, J. Richard. Evaluating Materials for Teaching with a Computer. Urbana, IL: University of Illinois Press, 1979. (6, 8, Appendix A)

Douglas, Shirley, and Gary Neights. A Guide to Instructional Microcomputer Software. Harrisburg: Pennsylvania Department of Education, n.d. (4, 5, 6, 7, 8, 27, 42, Appendix A)

Eldredge, Bruce, and Kenneth Delp. "How to Evaluate Educational Computer Programs." Media and Methods, 17.7 (March 1981): 4 et passim. (28, 42)

Elliott, Peggy, Gary M. Ingersoll, and Carl B. Smith. Trends in Educational Materials Traditionals and the New Technologies. Bloomington, IN: Educational Research Association of Indiana, (1983): 1-20. (1, 10, 35)

Fetter, Wayne R. "Guidelines for Evaluation of Computer Software. Educational Technology, 24.3 (March 1984): 19-21. (13, 36, Appendix A)

Fisher, Glenn. "Where CAI Is Effective A Summary of the Research." Electronic Learning, 3.3 (November/December 1983): 82-84. (14, 36)

_____. "The Social Effects of Computers in Education." Electronic Learning, 3.6 (March 1984): 26, 28. (17, 38)

Forman, Denyse. "Search of the Literature." The Computing Teacher, 9.5 (January, 1982): 37-51. (20, 39)

Freedman, Alan. The Computer Glossary: It's Not Just a Glossary! New York: The Computer Language Co., 1983. (6, 7, 9)

Gagne, Robert M., and Leslie J. Briggs. Principles of Instructional Design. New York: Holt, Rinehart, and Winston, 1974. (21, 39, 40, 46)

Gagne, Robert M., Walter Wager, and Alicia Rojas. "Planning and Authoring Computer-Assisted Instruction Lessons." Educational Technology, 21.9 (September 1983): 17-25. (22, 40)

Golas, Katherine C. "The Formative Evaluation of Computer-Assisted Instruction." Educational Technology, 23.1 (January 1983): 26-28. (24, 40)

Gold, Patricia Cohen. "Educational Software -- New Guidelines for Development." AEDS Journal, 18.1 (Fall 1984): 41-50. (21, 39)

Good, Carter U. Dictionary of Education. New York: McGraw-Hill, 1973. (6, 7)

Heck, William P., Jerry Johnson, Robert J. Kansky, and Dick Dennis. Guidelines for Evaluating Computerized Instructional Materials. Reston, VA: National Council of Teachers of Mathematics, 1984. (6, 8, Appendix A)

Jay, Timothy B. "The Cognitive Approach to Computer Courseware Design and Evaluation." Educational Technology, 23.1 (January 1983): 22-26. (26, 42)

Kansky, Bob, William Heck, and Jerry Johnson. "Getting Hard-Nosed about Software: Guidelines for Evaluating Computerized Instructional Materials." Mathematics Teacher, 74 (November 1981): 600-604. (31, 43)

Kohl, Herbert. "Who Should Be Evaluating Software?" Classroom Computer Learning, 5.2 (September 1984): 30-33. (12, 35-36)

Kulik, James A., Chen-Lin C. Kulik, and Peter A. Cohen. "Effectiveness of Computer-based College Teaching: A Meta-analysis of Findings." Review of Educational Research, 50.4 (Winter 1980): 525-544. (7, 19, 38-39)

Kulik, James A., Robert L. Bangert, and George W. Williams. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 75.1 (1984): 19-26. (18, 38, 39)

Manning, Anita. "Educational Software Is Put to the Test." USA Today, 6 March 1985a, sec. D, p. 3D. (13, 36)

_____. "Good Learning Software Is Hard to Find." USA Today, 6 March 1985b, sec. D, p. 1D. (13, 36)

Orlansky, Jesse. "Effectivenees of CAI: A Different Finding." Electronic Learning, 3.1 (September 1983): 58-60. (19, 39)

Otte, Richard, Project Monitor. Evaluator's Guide for Microcomputer-Based Instructional Packages. Eugene, OR: International Council for Computers in Education, 1984. (5, 6, 7, Appendix A)

Pepper, Jeff. "Following Students' Suggestions for Rewriting a Computer Programming Textbook." American Educational Research Journal, 18.3 (Fall 1981): 259-269. (33, 44)

Robinson, Jack E. "Can 'Soft' Data Be Used to Evaluate the Effectiveness of Educational Technologies?" Educational Technology, 23.6 (June 1983): 17-21. (32, 44)

Roblyer, M. D. "When Is It 'Good Courseware'? Problems in Developing Standards for Microcomputer Courseware." Educational Technology, 21.10 (October 1981): 47-54. (23, 40)

Roblyer, M. D., and F. J. King. "Directing the Course of Educational Computing Why Common Sense Isn't Enough." Electronic Learning, 2.8 (May/June 1983): 22-24. (25, 41)

Rose, Shelley Yorke, and Carol Klenow. "The DISC Model for Software Evaluation and Support Material Design." The Computing Teacher, 11.1 (August 1983): 32-33. (11, 35)

Rose, Stephan A., et al. "Social Studies Microcomputer Courseware Evaluation Guidelines." Social Education 48.7 (November/December 1984): 573-576. (29, 42-43)

Savitsky, David. "A Publisher's Guidelines for Educational Development." Educational Technology, 24.4 (April 1984): 45. (29, 43)

Signer, Barbara. "How Do Teacher and Student Evaluations of CAI Software Compare?" The Computing Teacher, 11.3 (October 1983): 34-36. (33, 44)

Smith, Carl B., and Gary Ingersoll. "Microcomputers in U.S. Schools Who Uses Them? Any Impact to Date?" Indiana Reading Quarterly, 17.2 (Winter, 1985): 11, 25, 26. (1)

Steele, Kathleen J., Michael T. Battista, and Gerald H. Krockover. "The Effect of Microcomputer-Assisted Instruction on the Computer Literacy of Fifth Grade Students." Journal of Educational Research, 76.5 (May/June 1983): 298-301. (18, 38)

Steffin, Sherwin A. "Come In and Play with Me Computer Simulations: A Key to Divergent Thinking." Media and Methods, 18.2 (October 1981): 12-13. (30, 43)

_____. "A Suggested Model for Establishing the Validity of Computer-Assisted Instructional Materials." Educational Technology, 23.1 (January 1983): 20-22. (25, 41)

Steinberg, Esther R. "Reviewing the Instructional Effectiveness of Computer Courseware." Educational Technology, 23.1 (January 1983): 17-19. (27, 42)

Suppes, Patrick, and Mona Morningstar. "Computer-Assisted Instruction." Science, 166 (October 1969): 343-350. (15, 36-37)

Truett, Carol. "Field Testing Educational Software: Are Publishers Making the Effort?" Educational Technology, 24.5 (May 1984): 7-12. (32, 44)

Vinsonhaler, John F., and Ronald K. Bass. "A Summary of Ten Major Studies on CAI Drill and Practice." Educational Technology, 12.7 (July 1972): 29-32. (15, 37)

Wade, T. E., Jr. "Evaluating Computer Instructional Programs and Other Teaching Units." Educational Technology, 20.11 (November 1980): 32-35. (22, 39, 40)

Watt, Dan. "Computer Evaluation Cometh." Popular Computing, 3.9 (July 1984): 91, 94. (28, 42)

Watt, Molly. "Making a Case for Software Evaluation." The Computing Teacher, 9.9 (May 1982): 20-22. (26, 41)

Yates, Daniel S. "In Defense of CAI: Is Drill-and-Practice a Dirty Word?" Curriculum Review, 22.5 (December 1983): 55-57. (17, 37, 38)

APPENDIX A

Selected Software Evaluation Forms Surveyed

1. "AIRSware Evaluation Form." Andover Public Schools, Shawsheen School, Andover, MA 01810, 1983.

2. "CEE and Its Big 3 Software Evaluation." Joint Council on Economic Education, 1212 Avenue of the Americas, New York, NY 10038

3. "Computer Courseware Review Form." Minnesota Educational Computing Consortium, 2520 Broadway Dr., St. Paul, MN 55113, 1981.

4. "Computer Software Review Form.", undocumented.

5. Dearborn, Donald E. "Alexandria City Public Schools Computer Software Evaluation Form." NASSP Bulletin, 66.1 (September 1982): 28-29.

6. Dennis, J. Richard. "Courseware Evaluation Worksheet." Educational Application of Computers, No. 5e, Department of Secondary Education, College of Education, University of Illinois at Urbana-Champaign, Urbana, IL 61801, 1979.

7. Douglas, Shirley, and Gary Neights. "Microcomputer Instructional Software Evaluation Form." A Guide to Instructional Microcomputer Software. Instructional Materials Service Programs, Pennsylvania Department of Education, Box 911, 333 Market Street, Harrisburg, PA 17108, n.d.

8. "Evaluating Instructional Computer Courseware." Materials Review and Education Center, Department of Public Instruction, Education Bldg., Salisbury and Edenton Sts., Raleigh, NC 27611, n.d.

9. "Evaluation Form.", undocumented.

10. "Evaluation Form (Computer Software).", undocumented.

11. "Evaluation of Microcomputer Courseware." TECC and California Library Media Consortium for Classroom Evaluation of Microcomputer Courseware, San Mateo County Office of Education, 333 Main St., Redwood City, CA 94073, 1984.

12. Fetter, Wayne R. "Evaluation of Computer Programs." Educational Technology, 24.3 (March 1984): 20-21.

13. "Guidelines for Software Evaluation, Houston Independent School District, Department of Technology." School Library Media Quarterly, 12.2 (Winter, 1984): 117.

14. Heck, William P., Jerry Johnson, Robert J. Kansky, and Dick Dennis. "Software Evaluation Checklist." Guidelines for Evaluating Computerized Instructional Materials. The National Council of Teachers of Mathematics, Inc., 1906 Association Dr., Reston, VA 22091, 1984.

15. Otte, Richard, Project Monitor. "MicroSIFT Courseware Evaluation." Evaluator's Guide for Microcomputer-Based Instructional Packages. Developed by MicroSIFT, The Computer Technology Program, Northwest Regional Educational Laboratory, Published by International Council for Computers in Education, University of Oregon, 1787 Agate St., Eugene, OR 97403, 1984.

16. "Sample Software Evaluation Form." Guide to the Software Assessment Procedure. NEA Educational Computer Service, P.O. Box 70267, Washington, D.C. 20088, 1983.

17. "School Microware Evaluation Form.", undocumented.

18. "Software Evaluation Form." Electric Learning, 2.2 (October 1982): 47-48.

19. "Software Evaluation Form." Follett Library Book Co, 4506 Northwest Highway, Crystal Lake, IL 60014, 1983."

20. Talafuse, Marianne. "Feedback." Center for Economic Ecucation, Ball State University, Muncie, IN 47306 n.d.

21. Troutner, Joanne. "Sample Software Evaluation Form." The Media Specialist, The Microcomputer, and the Curriculum. Littleton, CO.: Libraries Unlimited, 1983: 30-31.

22. VanSickle, Ronald L. "Software Evaluation Form." Center for Economic Education, University of Georgia, Athens, GA n.d.

APPENDIX B - ANALYSIS OF INSTRUMENTS

Factor	Tot	*1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
OVERVIEW																							
Review/Nam/T	16	x	x	x	x	x	x			x	x	x			x	x	x	x	x	x		x	
Title	17	x	x		x	x		x		x	x	x	x		x	x		x	x	x	x	x	x
Pkg.Title	6			x		x	x					x							x	x			
Publisher	15	x	x	x	x	x		x		x	x	x	x		x	x			x	x			x
C'right Date	5	x				x							x						x	x			
Micro Brand	11	x		x		x				x	x	x	x		x				x	x			x
N'csy Hdw	11	x		x		x				x	x		x		x		x		x	x			x
Cost	11	x		x	x	x		x					x		x	x			x	x		x	
B'up Policy	5									x						x			x	x		x	
CreateDtaFil	2						x										x						
SubjArea/Top	19	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x		x	x
Grade Level	19	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	
Ind./Group	9	x		x		x								x	x				x	x		x	x
Execution Tm	12	x	x		x	x	x		x				x		x	x	x	x					x
Prereq/Skls	11	x			x	x	x		x							x	x		x	x			x
Type/Prog	17	x	x	x		x	x	x	x	x	x	x	x		x	x	x		x	x		x	
Obj Stated	17	x		x	x	x	x	x	x		x	x	x	x		x	x		x	x		x	x
Obj Achvd	11	x		x		x	x	x			x	x				x	x		x	x			
Prog Desc	12		x		x		x	x		x		x			x	x	x		x	x	x		
Lang/Mem Req	4	x													x							x	x

* Bibliographic reference to documents - See Appendix A

APPENDIX B - ANALYSIS OF INSTRUMENTS (continued)

Factor	Tot	*1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EDUCATIONAL CONTENT																							
Apprp/Comp	12	x		x		x					x	x		x		x	x		x	x	x	x	
Cnt Accurate	16	x	x	x		x	x			x	x	x	x	x		x	x	x	x	x		x	
ConstDiffLvl	6	x							x			x							x	x		x	
Bias Free	11	x	x			x			x	x		x				x	x		x	x		x	
Instr Focus	2						x								x								
InstrSignif	11		x			x	x		x	x		x			x	x	x					x	x
Sound/Valid	6			x			x		x						x		x						x
CompatOthMtl	3						x								x		x						
Creative	1											x											
Crect G/S/P	6			x	x				x			x					x						x
Free/Viol	1											x											
Info/SlvProb	2						x		x														
Appr for Aud	8		x	x		x			x		x		x			x							x

* Bibliographic reference to documents - See Appendix A

APPENDIX B - ANALYSIS OF INSTRUMENTS (continued)

Factor	Tot	*1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
PRESENTATION																							
Free TechPr	10					x	x					x		x	x	x	x		x	x		x	
Clear Instr	14		x	x	x		x		x			x	x		x	x	x		x	x		x	x
Instr to Scr	4			x			x					x					x						
Skip Instr	2											x		x									
Log/WellOrg	12		x	x	x	x	x		x	x		x		x			x		x	x			
NoExtInfNeed	2	x													x								
Gr/Sd/Cl Enh	21	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Disp Clear	17	x	x	x	x		x		x	x		x		x	x	x	x		x	x	x	x	x
Good Animtn	2																x						x
SoundAppr	9		x		x		x		x	x		x			x		x						x
Color Eff	7		x		x		x		x			x					x						x
Quality Op	3				x		x								x								
Game Fmt	5						x		x			x			x		x						
Use Rndm Ord	2	x										x											
Sources Ident	7			x	x							x	x				x					x	x
Varied Fmt	4		x		x				x	x													
Rdg Lvl App	9		x	x	x					x			x				x	x	x				x

* Bibliographic reference to documents - See Appendix A

APPENDIX B - ANALYSIS OF INSTRUMENTS (continued)

Factor	Tot	*1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
INTERACTION																							
Feedbk Eff	13	x	x	x			x			x	x		x	x		x	x		x	x			x
Feedbk Monot	3		x							x							x						
CuesPrmt Hlp	10		x	x			x			x		x					x		x	x	x	x	
User/AccMem	8						x		x	x				x			x		x	x	x		
User/GetHelp	6				x		x					x		x			x				x		
Chng Act	4						x					x		x			x						
Cntrl/Pace	16	x	x	x	x		x		x	x		x	x	x	x	x	x		x	x			x
Safe/A'g Cr	10		x		x							x	x		x		x		x	x		x	x
SmplUserI'pt	6		x				x			x					x	x	x						
ActvUserInvl	5			x			x				x				x								x
Brch/Linear	8			x			x	x	x			x	x				x						x
Ans/Corble	5		x				x			x		x					x						
EasyInteract	9	x		x	x		x	x	x					x		x	x						
PosResp/Suc	7		x				x		x			x	x				x						x
Resp/Non-Jdg	4						x		x			x					x						

* Bibliographic reference to documents - See Appendix A

APPENDIX B - ANALYSIS OF INSTRUMENTS (continued)

Factor	Tot	*1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
TEACHER USE																							
RecKpgPoss	14		x	x			x	x	x	x	x	x	x				x		x	x		x	x
Mgmt/EasyU	4			x			x					x		x									
Teach/Montr	10		x							x			x	x	x	x	x		x	x			x
Be Modified	8						x		x			x		x			x		x	x		x	
ManualAvail	8		x		x					x	x	x	x			x	x						
Doc/Clear	13	x	x		x				x	x			x	x		x	x		x	x		x	x
Flexible	4			x									x		x		x						
WrkSht/ReAct	11		x	x	x	x			x			x			x	x	x					x	x
Tests/Pr/Po	2											x				x							
Validtd/FT	9			x				x	x		x		x		x	x	x	x					
Reltd/Text	4				x			x			x					x							

* Bibliographic reference to documents - See Appendix A

APPENDIX B - ANALYSIS OF INSTRUMENTS (continued)

Factor	Tot	*1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
STUDENT POINT OF VIEW																							
Comp w/Othrs	3		x				x								x								
Coop /Othrs	1														x								
Comptr/Human	7				x		x					x	x		x		x					x	
Moral Values	5	x	x							x				x	x								
ObsBehv/User	7			x			x	x				x			x	x	x						
Prob.Expr	2		x									x											
Stim/Creatv	4										x		x			x					x		
Strengths	7	x										x				x		x	x		x	x	
Weaknesses	6	x								x						x		x		x		x	
Source/Help	3						x		x							x							
Behav/Terms	2						x		x														
Feedbk/WrngAn	2						x		x														
Remdl/GrLvl	3			x				x					x										
Motivates	4					x							x			x					x		
Effect/Lrng	1													x									

* Bibliographic reference to documents - See Appendix A

57c

Appendix C

Survey of Questions on Selected Evaluation Forms

Graphics,Sound,Color Enhance	21	95%
Subject Area/Topic	19	86%
Grade Level	19	86%
Display clear and easily read	17	77%
Objectives stated	17	77%
Title	17	77%
Type of Program	17	77%
Can Control Pace and Sequencing	16	73%
Content Accurate	16	73%
Reviewer's Name and Date	16	73%
Publisher	15	68%
Clear Instructions	14	64%
Record Keeping Possible	14	64%
Documentation Clear/Comprehensive	13	59%
Feedback Effective	13	59%
Appropriate For Computer	12	55%
Description of Program	12	55%
Execution Time	12	55%
Logical, Well Organized	12	55%
Bias Free	11	50%

Cost ---------- 11 -- 50%

Has Worksheets/Related Activities ---- 11 -- 50%

Instructional Significance ---------- 11 -- 50%

Microcomputer Brand ---------- 11 -- 50%

Necessary Hardware ---------- 11 -- 50%

Objectives Achieved ---------- 11 -- 50%

Prerequisite Skills ---------- 11 -- 50%

Cues/Prompts Help ---------- 10 -- 45%

Free Of Technical Problems ---------- 10 -- 45%

Must Teacher Monitor ---------- 10 -- 45%

Safeguards Against Crashing ---------- 10 -- 45%

Easy Interaction/Easy To Use --------- 9 -- 41%

Individual/Group Size ---------- 9 -- 41%

Reading Level Appropriate ---------- 9 -- 41%

Sound Appropriate - Can Turn Off ----- 9 -- 41%

Validation/Field Tested ---------- 9 -- 41%

Appropriate For Target Audience ------ 8 -- 36%

Branching/Linear ---------- 8 -- 36%

Can Teacher Modify ---------- 8 -- 36%

Has Documentation Manual ---------- 8 -- 36%

User Can Accsess Menu ---------- 8 -- 36%

Computer Is Humanized ---------- 7 -- 32%

Gives Scores To User ---------- 7 -- 32%

Observed Behavior Of User ---------- 7 -- 32%

Response To Success Positive --------- 7 -- 32%

Strengths ---------- 7 -- 32%

Consistent Difficulty Level ---------- 6 -- 27%

Correct Grammar/Spelling/Punc. ------- 6 -- 27%

Package Title ------------------------ 6 -- 27%

Simple User Input -------------------- 6 -- 27%

Soundness/Validity ------------------- 6 -- 27%

User Can Get Help -------------------- 6 -- 27%

Weaknesses --------------------------- 6 -- 27%

Active User Involvement -------------- 5 -- 23%

Answers May Be Corrected ------------- 5 -- 23%

Backup Policy ------------------------ 5 -- 23%

Copyright Date ----------------------- 5 -- 23%

Game Format -------------------------- 5 -- 23%

Moral Values/Value Judgements -------- 5 -- 23%

Correlated With Text ----------------- 4 -- 18%

Flexibility -------------------------- 4 -- 18%

Instructions Recalled To Screen ------ 4 -- 18%

Language/Memory Requirements --------- 4 -- 18%

Management Easy To Use --------------- 4 -- 18%

Motivates ---------------------------- 4 -- 18%

Response Non-judgemental ------------- 4 -- 18%

Stimulates Creativity/Exploration ---- 4 -- 18%

User Can Change Activity ------------- 4 -- 18%

Varied Format ------------------------ 4 -- 18%

Compatible With Other Materials ------ 3 -- 18%

Competition With Others -------------- 3 -- 14%

Feedback Monotonous ------------------ 3 -- 14%

Gives Outside Source For Help -------- 3 -- 14%

Quality Of Tone And Output ---------- 3 -- 14%

Remedial/On Grade/Enrichment --------- 3 -- 14%

Can Skip Instructions ---------------- 2 -- 9%

Creates Data Files ------------------- 2 -- 9%

Does Not Need External Information --- 2 -- 9%

Gives Feedback/Explains Wrong Answers- 2 -- 9%

Gives Information To Solve Problems -- 2 -- 9%

Good Use Of Animation ---------------- 2 -- 9%

Has Tests Pre/Post ------------------- 2 -- 9%

Instructional Focus ------------------ 2 -- 9%

Specif Expec Results In Behav.Terms -- 2 -- 9%

User Problems Observed --------------- 2 -- 9%

Uses Random Order -------------------- 2 -- 9%

Cooperation With Others -------------- 1 -- 5%

Creative ----------------------------- 1 -- 5%

Free Of Violence --------------------- 1 -- 5%

APPENDIX D

USEFUL MATERIALS NOT CITED

1. "Criteria for Evaluation of Computer Software." Indiana Clearinghouse for Computer Education, Indiana University-Purdue University at Indianapolis, 902 West New York Street, Education Social Work Building, Room 2131, Indianapolis, IN 46223, n.d.

2. "Microcomputer Software Evaluation Instrument." National Science Teachers Association, 1742 Connecticut Ave.,NW, Washington, D.C., 20009, 1983.

3. "Scholastic Software Evaluation Form.", Scholastic, Inc., 730 Broadway, New York, NY 10003, n.d.

4. "Teacher Microcomputer Software Evaluation Form." Northwest Consolidated Schools of Fairland and School of Library and Info. Science, Indiana University, Bloomington, IN, n.d.

5. "T-E-S-S The Educational Software Selector" Educational Products Information Exchange (EPIE) Institute, Teachers College Press, 1234 Amsterdam Ave., New York, NY 10027, 1984.

6. "The Executive Review.", undocumented.

7. "The 1985 Educational Software Preview Guide." California TECC Software Library and Clearinghouse, SMERC Library and Microcomputer Center, San Mateo County Office of Education, 333 Main St., Redwood City, CA 94063, 1985

Note: A packet containing all of the above is available free to teachers in Indiana. Send a self-addressed 9 x 11 envelope with two first class stamps to: Indiana Clearinghouse for Computer Education. (See address above.)